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- **Dennis, Douglas A.**  
Littleton, CO 80128 (US)
- **Smith, Matthew**  
Akron, IN 46910 (US)

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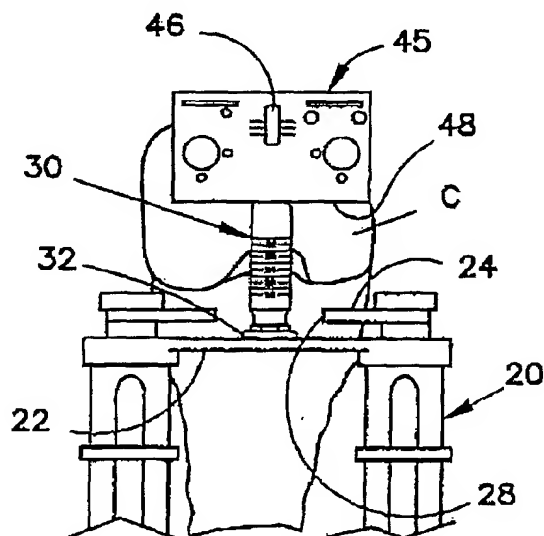
(71) Applicant: **DePuy Orthopaedics, Inc.**  
**Warsaw, IN 46581 (US)**

(74) Representative: **Belcher, Simon James**  
**Urquhart-Dykes & Lord**  
**Tower House**  
**Merrion Way**  
**Leeds LS2 8PA (GB)**

(72) Inventors:  
• **Smith, Bryan J.**  
**Ft. Wayne, IN 46804 (US)**

(54) **Instruments for flexion gap adjustment of a knee prosthesis**

(57) A flexion gap instrument is configured to mate with a ligament tensioning tool, such as known distraction devices and pivoting knee balancers. The instrument facilitates making A/P resections in the femur for placement of a femoral prosthesis component to maintain an optimum symmetric flexion gap, which will avoid the risk of medial or lateral laxity in flexion, instability of articulating component dislocation. The instrument includes a base that is configured to sit within the ligament tensioning device, and a vertically extending upstanding portion that is configured to mate with a cutting block or other knee arthroplasty instrument that must be positioned relative to the distal end of the femur. The upstanding portion includes a measurement plate that bears a scale indicating a flexion gap distance. The scale can be used to orient and align the cutting block in its proper position relative to the distal end of the femur, and to orient the cutting block parallel with the tibial plateau with the ligaments properly and equally tensed. In certain embodiments, a leaf spring can be incorporated into the upstanding portion to help support the cutting block and provide means for temporarily positioning the cutting block on the flexion gap instrument without the need for additional or supplemental locks.



**FIG. 10**

## Description

[0001] This invention relates to instruments and method for reconstructing a femoral portion of a knee in preparation for a total knee replacement. More particularly, the invention relates to systems and methods for orienting a cutting block used to resect portions of the femur, and more specifically in such a way as to balance medial and lateral collateral ligament tension.

[0002] The typical total knee arthroplasty includes three components, as depicted in FIG. 1. In particular, the knee prosthesis 10 includes a femoral component 12, a spacer 13, and a tibial component 14. The design of the components of the knee prosthesis 10 is complicated by the fact that the natural knee does not operate like a hinge moving about a single axis. The knee exhibits dynamic external rotation of the tibia relative to the femur as the knee moves from its flexed to its fully extended position. This automatic rotation of the tibia occurs in the opposite direction when the knee is flexed from its fully extended position to produce an internal rotation of the tibia relative to the femur.

[0003] Thus, the natural knee exhibits a rotary laxity that allows the tibia to rotate through a limited arc of both internal and external motion at every degree of knee flexion. While the configuration of the components 12-14 themselves is important to achieve proper knee motion, the specific placement of these components is also critical. Most particularly, the proximal/distal and anterior/posterior positions of the femoral component 12 are critical for duplicating the kinematics of the knee. Much literature and clinical study has been devoted to determining the proper orientation of the prosthesis components, and particularly the femoral component 12.

[0004] As is known in the field of total knee arthroplasty, and as can be discerned from FIG. 1, the femoral component 12 exhibits a three-dimensional saddle configuration. The interior of the component is configured to mate with a prepared end of the femur. For the typical femoral component, the orthopaedic surgeon must make five cuts at the proximal end of the femur, as illustrated in FIG. 2. In a typical procedure, a distal cut 1 is made across the distal end of the femur F. The anterior-to-posterior (A/P) placement of the femoral component is determined by the anterior and posterior cuts 2 and 3, respectively. Once those cuts are complete, angled chamfer cuts 4 and 5 are typically made to help secure the femoral component 12 solidly in place. In order to effectively and accurately make these resections, orthopaedic surgeons will typically use a cutting block or cutting guide that is temporarily affected to the distal end of the femur F.

[0005] One important factor in determining the proper position of the femoral component, and therefore the proper location for the various cuts 1-5, is the tension in the adjacent soft tissues, particularly the collateral ligaments. Proper tension in the collateral ligaments pre-

vents sideways toggle of the leg. In addition, the collateral ligaments help to limit anterior/posterior travel of the femur relative to the tibia. The spacer 13 (FIG. 1) is an important component for maintaining the proper tension in the collateral ligament. With respect to a prosthetic knee, such as the prosthesis 10, the spacer 13 is necessary to account for the gap that occurs between the distal end of the femur F and the proximal end of the tibia, after portions of both bone ends have been resected.

[0006] Knee instruments have evolved that provide means for mechanically distracting the knee joint to exert the proper tension on the ligaments during the knee arthroplasty procedure. One such instrument is illustrated in FIGS. 3-5. In particular, a distraction device 20 can include a lower member 22 that is adapted to contact the tibia plateau P (FIG. 4) of the tibia T. The distraction device also includes an upper member 24 that contacts the distal end of the femur F, preferably after the first distal cut (cut 1 in FIG. 2) has been performed. With this type of distraction device, the upper member 24 includes a medial and a distal member 24a and 24b, respectively, as depicted in FIG. 5. A pair of parallel adjusting members 26 adjust the position of the two upper members 24a, b relative to the lower member 22. Preferably, the adjusting members 26 operate independently so that the medial upper member 24a can be adjusted differently from the distal member 24b. This independent adjustability of the medial and distal members allows the surgeon to properly orient the mechanical axis of the knee joint relative to the leg bones. Each adjusting member 26 can include an indicator 27 which provides an indication of the joint space, and ultimately the amount of tension applied to the ligaments. The distraction device 20 can be of a variety of types. For the purposes of illustrating the preferred embodiment of the present invention, a distraction device such as the device disclosed in US-4501266 can be implemented.

[0007] In a typical knee arthroplasty procedure, the ligament tension is evaluated with the knee joint in its extended position - i.e. with the femur F and tibia T in alignment. In this position, the prepared surfaces of the femur and tibia are distracted apart by an extension gap G. The ligament tension can be corrected by releasing soft tissue attachments if a medial-lateral imbalance exists, thereby producing a symmetric or parallel extension gap. With this approach, the remainder of the arthroplasty procedure is geared toward maintaining this extension gap.

[0008] However, this approach does not account for proper tensioning of the knee when it is in flexion - i.e., when the knee joint is bent. It is with this type of movement that the A/P position of the femoral component 12 is most critical. If the component is offset incorrectly in the A/P direction, the flexion gap will not be correct and will not generate the proper amount of tension in the collateral ligaments. Thus, while the "extension gap first" approach generally assures a proper extension gap, this

same approach does not translate to insuring a proper flexion gap. If the flexion gap is incorrect, the ligaments may be too loose or too tight, or the range of motion of the knee may be limited. In addition, poor tensioning in flexion can lead to improper femoral rotation, condylar lift-off, accelerated wear of the prosthesis components, and even spin-out or dislocation of the femoral-tibial articulation. It is therefore important to derive a proper A/P position for the femoral component **12**.

**[0009]** Some procedures exist which begin with evaluating the flexion gap and then utilizing this flexion gap as the benchmark for the sizing and positioning of the knee prosthesis components. An approach of this type is disclosed in US-6056756. While the system and method disclosed in this document correlates to the flexion gap, the A/P placement of the femoral component is made with reference to bony landmarks on the femur, and not with reference to the flexion gap itself. Moreover, the approach in this document makes no account for a proper extension gap, except to the extent that sizing of the prosthesis components relative to the flexion gap achieves similar results when the knee is in extension.

**[0010]** Consequently, there is a need for an instrument and technique that more accurately locates the femoral component on the prepared distal end of the femur. This need is particularly acute with respect to the A/P placement of the femoral component, which is ultimately a function of the resection cuts made in the distal end of the femur (see **FIG. 2**). Thus, the need extends to providing an instrument and method for accurately orienting and positioning the cuts that need to be made in the femur to achieve a properly sized femoral component.

**[0011]** To address these needs, the present invention contemplates a flexion gap instrument that is configured to mate with a ligament tensioning tool, such as known distraction devices and pivoting knee balancers. The instrument allows A/P positioning of a cutting block or other knee arthroplasty device to produce a proper flexion gap in the reconstructed knee.

**[0012]** Accordingly, the present invention contemplates a flexion gap instrument that is configured to mate with a ligament tensioning tool, such as known distraction devices and pivoting knee balancers. The flexion gap instrument includes a base that is configured to sit within the ligament tensioning device, and a vertically extending upstanding portion that is configured to mate with a cutting block or other knee arthroplasty instrument that must be positioned relative to the distal end of the femur. The vertical I-beam in one embodiment can be formed by a back plate and a forward measurement plate. The measurement plate includes a scale indicating a flexion gap distance which can be used to orient and align the cutting block in its proper position relative to the distal end of the femur. In certain embodiments, a leaf spring can be incorporated into the I-beam to help support the cutting block and provide means for temporarily positioning the cutting block on the flexion gap in-

strument without the need for additional or supplemental locks.

**[0013]** In one embodiment of the invention, the flexion gap instrument includes a base that is configured to sit within the ligament tensioning device, and a vertically extending upstanding portion that is configured to mate with a cutting block or other knee arthroplasty instrument that must be positioned relative to the distal end of the femur. The upstanding portion in one embodiment is an I-beam upstanding portion formed by a back plate and a forward measurement plate. The measurement plate can include a scale or other marker indicating a flexion gap distance which can be used to orient and align the cutting block in its proper position and orientation relative to the distal end of the femur. In a preferred embodiment, the vertically extending upstanding portion is substantially perpendicular to the base. The upstanding portion is arranged so that the supported cutting block is oriented to the cut tibia while the ligaments are tensed to create a symmetric (balanced medial-lateral) flexion gap.

**[0014]** In certain embodiments, a leaf spring can be incorporated into the I-beam to help support the cutting block and provide means for temporarily positioning the cutting block on the flexion gap instrument without the need for additional or supplemental locks. In other embodiments, the vertical extending upstanding portion is in the form of a T-shape for slidable positioning within a correspondingly shaped channel in a cutting block. An alternative feature of the invention contemplates placing the measurement plate at a non-perpendicular angle relative to the base to accommodate particular cutting block designs and to place the block in a desired orientation relative to the tibia.

**[0015]** One aspect of the invention contemplates a method for calibrating a flexion gap relative to a known extension gap value as part of a knee arthroplasty procedure. This method can include the steps of placing the knee joint in flexion, distracting the knee joint, and then placing an instrument relative to the tibia that includes a scale juxtaposed to the distal end of the femur. The scale denotes a gap dimension between the prepared end of the tibia and a particular location on the prepared end of the femur. In the next step, a position on the scale is located that corresponds to a known gap value. All of these steps occur while maintaining the distraction of the knee joint.

**[0016]** In a preferred embodiment, the gap value corresponds to a pre-determined extension gap value. Thus, in a prior series of steps, the knee can be placed in extension, distracted using the distraction device, and the extension gap measured. This measurement can be located on the scale of the flexion gap instrument to determine a proper flexion gap location. This location on the scale can then be used to orienting a cutting block on the femur with a portion of the cutting block aligned with the located position on the scale corresponding to the known extension gap value. The inventive instru-

ment is used to orient the cutting block parallel to the cut proximal end of the tibia while the ligaments are maintained in tension by a distraction tool. In this way, a flexion gap can be established that does not vary between the medial and lateral aspects.

[0017] The inventive method can include means for temporarily supporting the cutting block on the instrument. The cutting block can then be mounted on the femur to make the appropriate proximal and distal cuts of the distal end of the femur.

[0018] In certain aspect of the invention, the distraction device can be an independent knee balancer device. In other embodiments, the distraction device is a pivoting knee balancer. With each type of distraction device, the flexion gap instrument can be positioned or mated with the distraction plates of the instrument so as not to interfere with the operation of the distraction device.

[0019] In one embodiment of the invention, an instrument for establishing the flexion gap of a knee joint in flexion is provided that comprises a base portion configured for placement relative to the proximal end of the tibia with the knee joint in flexion. The instrument also includes a plate projecting from the base portion that is configured to be juxtaposed relative to the distal end of the femur when the base portion is placed relative to the tibia. In a preferred embodiment, the base is configured to rest directly on the tibial plateau, or within the tibial plateau mating plate of the distraction device or ligament balancing tool.

[0020] Preferably, indicia are carried by the plate to define a gap dimension measured from the proximal end of the tibia. In certain embodiments, at least a portion of the plate bearing said indicia is sized to be slidably received in a channel of a cutting block. The instrument can also include means for supporting the cutting block on said plate. In certain embodiments, this means for supporting can include a leaf spring connected to the plate, with the leaf spring arranged to bear against the channel of the cutting block.

[0021] Preferably, the plate projects substantially perpendicularly from the base. In other embodiments, adapted for use with different cutting blocks, at least a portion of the plate bearing the indicia is oriented at a non-perpendicular angle relative to the base.

[0022] It is one object of the invention to provide an instrument for determining a flexion gap that can be used during a total knee arthroplasty procedure. A primary goal is to produce a prosthetic knee joint that maintains proper ligament tension in both extension and flexion.

[0023] One benefit of the present invention is that it provides a means for determining a proper flexion gap when the distal end of the femur is being prepared for the prosthesis. Another benefit is that the inventive instrument and method can be used concurrently with existing distraction devices, without interfering with the function of those devices.

[0024] Embodiments of the invention will now be described by way of example with reference to the accompanying drawings, in which:

**FIG. 1** is an exploded perspective pictorial view of a typical knee prosthesis.

**FIG. 2** is a side view of the distal end of a femur illustrating the various cuts made to prepare the femur for a femoral component of the prosthesis shown in **FIG. 1**.

**FIG. 3** is a front view of an extended knee joint with a known distraction device operating on the joint.

**FIG. 4** is a side view of the knee and the distraction device shown in **FIG. 3**.

**FIG. 5** is a top elevational view of the typical distraction device shown in **FIGS. 3** and **4**.

**FIG. 6** is a side perspective view of a flexion gap instrument in accordance with one embodiment of the present invention.

**FIG. 7** is a side view, similar to the side view in **FIG. 4**, showing the flexion gap instrument mounted within the distraction device shown in **FIG. 3** and **4**.

**FIG. 8** is a side elevational view of the flexion gap instrument shown in **FIG. 6**.

**FIG. 9** is a front elevational view of the flexion gap instrument shown in **FIGS. 6** and **8**.

**FIG. 10** is a front view of a knee in flexion with the flexion gap instrument of one embodiment of the present invention supported within a distraction device, such as the device shown in **FIGS. 3** and **4**, and with one type of cutting block shown in a position prior to mounting on the flexion gap instrument.

**FIG. 11** is a front view similar to the view of **FIG. 10** with the cutting block shown positioned over the flexion gap instrument of the present invention.

**FIG. 12** is a side perspective view of the use of one embodiment of the flexion gap instrument in connection with a known pivoting knee balancer.

**FIG. 13** is a front prospective view of a flexion gap instrument in accordance with an alternative embodiment of the present invention, shown in use in connection with a known distraction device and a known cutting block.

**FIG. 14** is a side view of the flexion gap instrument shown in **FIG. 13**.

**FIG. 15** is a front view of the flexion gap instrument shown in **FIG. 14**.

[0025] Referring to the drawings, **FIG. 6** shows a flexion gap instrument **30** which is configured for placement within a ligament tensioning device, such as the distraction device **20** shown in **FIGS. 3-5**. More specifically, the flexion gap instrument **30** is arranged to fit within the central slot **28** defined between the two medial and distal upper members **24a**, **24b**. In some embodiments, the lower member **22** can define a portion of the central slot **28** within which the instrument is disposed. In other embodiments, the instrument **30** can be supported on or

within the lower member **22**.

[0026] Prior to positioning of the flexion gap instrument **30**, the femur **F** can be sized to determine a proper femoral component **12** (FIG. 1). Next, the proximal tibia is resected to form the tibia plateau **P** (FIGS. 4 and 7). The distal femur can also be cut, such as along the cut line **1** as shown in FIG. 2. In the next step, the soft tissues, and particularly the ligaments, are balanced in extension, as illustrated in FIGS. 3 and 4. Thus, the distraction device **20** can be used to produce an extension gap **G**. Any imbalance in the soft tissues can be corrected, such as by ligament release. Once the soft tissue surrounding the knee joint has been properly balanced, the extension gap **G** is sized.

[0027] In the next step, the knee is positioned in flexion as shown in FIG. 7. The distraction instrument **20** can be maintained in position as the tibia is moved to its flexed position, or the distraction device can be removed and then repositioned once the knee joint is in flexion. In the flexed position, the lower member **22** is positioned on the tibial plateau **P**, while the upper members **24a, b** contact the posterior condyles **C**. The ligament balancing tool, or the distraction device **20**, is adjusted so that the medial and lateral soft tissues are tensed an amount equal to that arising when the extension gap was evaluated. Thus, in this position, the distraction device **20** will generate a preliminary flexion gap **L** between the posterior condyles **C** and the tibial plateau **P**.

[0028] With the knee joint in flexion, and the distraction device in the position shown in FIG. 7, the flexion gap instrument **30** can be positioned within the slot **28** of the distraction device **20**. As shown in FIG. 6, the flexion gap instrument **30** includes a base **32** which can be configured to fit tightly within the slot **28** and contact the tibial plateau engaging plate of the distraction device. Alternatively, the lower surface of the base **32** can be configured to rest directly against the tibial plateau **P**. It is important that the base be positioned parallel to the tibial plateau whether resting on the bone or on the distraction device. In the illustrated preferred embodiment, an upstanding portion **33** projects generally perpendicularly from the base **32**. It is important that the upstanding portion **33** be situated perpendicular in the coronal or medial-lateral plane to position the cutting block parallel to the cut tibia while the ligaments are tensed. As shown in FIG. 7, with the knee flexed to 90°, this upstanding portion **33** extends generally parallel to the distal end of the femur **F**, and perpendicular to the tibial plateau **P**.

[0029] The upstanding portion **33** can be of an I-beam upstanding portion and can include a back plate **34** that directly faces the femur, and a forward measurement plate **36**. The measurement plate **36** includes a scale **37** or similar scale markings thereon to provide a visual indication of dimension. More specifically, the scale **37** provides markings corresponding to different gap dimensions. In the illustrated embodiment, these gap dimensions can commence at 16 mm, which corresponds

to a distance of 16 mm from the scale marking to the bottom of the tibial plateau engaging plate of the distraction device or ligament balancing device. Alternatively, the scale markings can be calibrated to the bottom surface of the base **32**. In addition, in the illustrated embodiment, the scale markings can be set at dimensions of 16, 20, 24, 28, and 32 mm, with intermediate 2 mm markings, as best shown in FIG. 9.

[0030] The base **32** can have a length that is less than the length of the slot **28** in the distraction device **20**. This permits the flexion gap instrument **30** to slide fore and aft relative to the prepared end of the distal femur **F**. In another aspect of the preferred embodiment, the upstanding portion **33** is offset to one end of the base **32**. The scale markings, such as scale **37** can be included on the back face of the back plate **34**, as well as on the front face of the measurement plate **36**. With this configuration, the instrument **30** can be associated with the distraction device in two orientations that allows the vertical measurement scale to be positioned closer to or further away from the distal end of the femur. In certain uses, the instrument can be initially placed in one orientation to measure the flexion gap, such as with the back plate **34** juxtaposed to the femur, and then repositioned or rotated 180° so that the upstanding portion is offset from the distal femur for supporting a cutting block.

[0031] In one method of use, the flexion gap instrument is initially position as shown in FIG. 7 set apart from the condyles **C** of the femur **F**. With the distraction device **20** and the flexion gap instrument **30** in this position and with the knee in flexion, a cutting block, such as the cutting block **45** shown in FIG. 10, can be positioned for mounting on the instrument **30**. The cutting block **45** can be of a variety of types. In the illustrated embodiment, the cutting block **45** includes an interior channel **46** that is sized to receive the flexion gap instrument **30** therein. The cutting block also includes a lower alignment edge **48** that is used with the present invention to define the flexion gap. As shown in FIG. 11, the cutting block **45** can also include fixation pins **50** that are used to temporarily fix the cutting block to the distal end of the femur while the particular bone resections are being made. The block can also include a number of cutting guides **52** in the form of slots sized for receiving known resection saws or osteotomes.

[0032] The flexion gap instrument is positioned over the proximal end of the tibia so that the measurement scale **37** is juxtaposed to the proximal end of the femur. In other words, the scale **37** is oriented so that it provides a direct visual relationship of the gap indicia to the end of the femur. Preferably, the knee joint is flexed to 90° so that the condyles **C**, or more appropriately the distal cut **1** (see FIG. 2) made in the femur, is generally perpendicular to the tibial plateau. With this orientation, the measurement plate **36** of the instrument **30** will be generally parallel with the prepared end of the femur, to allow accurate A/P positioning of the ancillary devices relative to the femur.

[0033] In some instances, the cut 1 in the distal end of the femur can be at an angle relative to the end plane of the condyles. In these instances, when the knee is flexed to the preferred 90° orientation, the prepared end of the femur is not perpendicular to the prepared tibial plateau. In order to accommodate this modified angle, the upstanding portion 33 can be oriented at a non-perpendicular angle relative to the base 32. In this way, the upstanding portion can be juxtaposed to the angled surface of the femur to provide an accurate flexion gap measurement and parallel positioning of the cutting block relative to the distal end of the femur.

[0034] As shown in FIG. 11, the cutting block 45 is mounted over the flexion gap instrument 30, with the instrument disposed within the interior channel 46 of the block. The block is positioned so that its alignment edge 48 is aligned with a particular value or indicator on the scale 37 of the measurement plate 36. In accordance with one aspect of the present inventive method, the extension gap G is measured when the knee is in extension as shown in FIGS. 3 and 4. The cutting block 45 is then arranged with its aligned edge 48 pointing to the particular value measured for the extension gap G. For instance, if the extension gap G is measured at 22 mm, then the alignment edge 48 of the cutting block 45 can be oriented at the 22 mm line on the scale 37 of the instrument 30.

[0035] In accordance with this illustrated embodiment, the cutting block 45 can be positioned so that the flexion gap value is the same as the extension gap value G. This similarity relies upon the uniform thickness of the femoral component 12 in its posterior and medial presentation. Of course, if the femoral component exhibits different geometry, in particular different thicknesses in these two orientations, the actual flexion gap value would be adjusted to account for this difference in thickness. However, for the purposes of the present invention, it is assumed that the femoral component 12 is uniform so that the extension gap value G can be used to establish a correct flexion gap that generates the optimum and correct amount of tension in the ligaments in both flexion and extension. Once the alignment edge 48 of the cutting block has been properly positioned, the cutting block 45 can be secured to the distal end of the femur F and the appropriate bone resections can be made.

[0036] In the preferred embodiment, the upstanding portion 33 is perpendicular to the tibial plateau in the sagittal plane of the knee. Thus, the rotational position of the cutting block in the plane parallel to the distal end of the femur will be controlled so that the cutting block will be substantially parallel to the tibial plateau. Proper rotational positioning of the cutting block helps ensure correct rotational positioning of the femoral prosthesis.

[0037] It should be appreciated that the flexion gap instrument 30 primarily provides a means for accurately determining the proper flexion gap so that the knee joint exhibits the same stability and flexion as it does in ex-

tension. In addition, it should also be appreciated that the instrument 30 allows the cutting block 45 to be positioned while the knee joint is being actively distracted and the surrounding soft tissues maintained in their accustomed tension. This approach ultimately ensures accurate A/P and rotational positioning of the cutting block, which leads to accurate cuts in the femur, and ultimately to optimum A/P and rotational positioning of the femoral component 12.

[0038] As illustrated in FIG. 10 and 11, the cutting block 45 is slid over the end of the I-beam upstanding portion 33 of the flexion gap instrument 30. This cutting block 45 includes an interior channel 46 into which the instrument 30 is received. In a preferred embodiment of the invention, the instrument 30 includes a web 39 spanning between the back plate 34 and the measurement plate 36 that helps insure stability of the two plates. In addition, the web can support a leaf spring 40 between the two plates 34 and 36. This leaf spring can exert moderate spring pressure against the interior of the cutting block 45 which can be sufficient to support the cutting block independently on the flexion gap instrument 30. Thus, this temporary support eliminates the need for any temporary fixation, such as bone pins extending through apertures in the cutting block.

[0039] In one specific embodiment, the leaf spring 40 can include leaf components on either side of the web 39 that project outwardly from that web. The spring can pass through a slot 42 defined at the upper end of the web 39 to help retain the leaf spring 40 in position. As an alternative, the spring element 40 can be arranged to exert a distracting force against the inside of the back plate 34 and the measurement plate 36. With this approach, the two plates would be nominally pushed apart by the spring 40 so that the plates would exert a friction force against the interior of the cutting block channel 46. With either approach, the cutting block 45 can be temporarily supported by the flexion gap instrument 30 until the fixation pins 50 are properly positioned within the distal end of the femur F.

[0040] The flexion gap instrument 30 in accordance with the present embodiment of the invention can be used with a variety of tensioning devices and cutting blocks. For instance, shown in FIG. 12, the flexion gap instrument 30 is shown supporting a cutting block 55 of a slightly different upstanding portion than the cutting block 45 illustrated in FIGS. 10 and 11. In this instance, the cutting block includes an alignment notch 56 defined at the lower end of the cutting block. This notch can be used to read the flexion gap values from the scale 37 on the flexion gap instrument 30.

[0041] In addition, as depicted in FIG. 12, the instrument 30 can be mated with a pivoting knee balancer 60. The knee balancer 60 can be of a variety of known upstanding portions. As with the distraction device 20, the knee balancer 60 includes a lower member 62 configured to contact the prepared end of the tibia, and a pair of upper members 64 that contact the condyles of the

femur **F**. The upstanding portion and use of a pivoting knee balancer **60** of this type is well known. The balancer includes an adjusting member **66** that permits adjustments in the spacing and angular orientation of the upper member **64** relative to the lower member **62**. Like the distraction device **20**, the pivoting knee balancer **60** provides a slot **68** between the upper members **64** and defined in the lower member **62**. Thus, the flexion gap instrument **30** can be readily disposed within that slot when the pivoting knee balancer **60** is in its operative position maintaining tension in the soft tissues surrounding the knee joint.

[0042] Other known cutting blocks have different upstanding portions from the cutting block **45** and **55** illustrated and discussed above. For example, as shown in FIG. 13, a cutting block **70** includes an open channel **71**. In accordance with certain known cutting blocks, the central channel **71** exhibits a t-shape. The block **70** also defines an open cutting guide **72** or slot that is arranged and sized to receive a cutting saw or osteotome.

[0043] In accordance with a further embodiment of the present invention, a flexion gap instrument **80**, shown in FIGS. 14 and 15, can be provided for use with this type of cutting block. Specifically, the instrument **80** includes a base **82** that can be similar to the base **32** of the flexion gap instrument **30**. The instrument **80** also includes a back plate **84** that faces the femur **F**, and a forward facing measurement plate **86**. As shown in the figures, the back plate **84** and measurement plate **86** are integral of each other, with the back plate defining a flange **85** around the side edges of the measurement plate **86**. Thus, the back plate and measurement plate form a "T" that is configured to be slidably received within the similarly shaped central channel **71** of the cutting block **70**. As with the flexion gap instrument **30**, the instrument **80** includes a scale **87** defined on the measurement plate **86**, which provides a visual indication of the measured flexion gap. The appropriate measurement on the scale **87** can be read by aligning the upper edge of the cutting guide **72** in the cutting block **70** with the appropriate scale value.

[0044] In another aspect of this embodiment of this invention, the flexion gap instrument **80** can include an angled arm **89** supporting the back plate and measurement plate on the base **82**. This configuration of the flexion gap instrument **80** can accommodate a particular configuration of cutting block, such as the cutting block **70**. Since the scale **87** is on the measurement plate **86** that is angled away from the perpendicular to base **82**, the measurement values on the scale must be adjusted accordingly. However, the use of the flexion gap instrument **80** can proceed as described above with respect to the flexion gap instrument **30**. The angle of the arm **89** can also be dictated by whether the prepared distal end of the femur is at an angle relative to the perpendicular, as discussed above.

[0045] The measurement plates **36**, **86** of the respective flexion gap instruments **30**, **80** have a length that is

sufficient to support the different cutting blocks therein. Moreover, the length of the measurement plates must be sufficient to accommodate a corresponding scale **37**, **87** that is capable of a wide range of gap measurements. In a preferred embodiment, the plates have a length of about 64 mm (2.5 inch) measured from the bottom face of the base **32**, **82**. With this preferred embodiment, the top of the plate will reach the anterior condyles of the femur for a normally distracted knee joint.

[0046] The flexion gap instruments of the present invention are preferably formed of a medical grade metal, such as stainless steel. However, since the instruments do not bear any substantial load, they can be formed of an alternative material, such as a medical grade plastic.

[0047] It can be appreciated that the present invention contemplates an instrument that is well-suited for an "extension gap first" knee arthroplasty approach. Once the extension gap has been evaluated, the instrument, such as instrument **30** or **80**, can be utilized with the knee joint in flexion to properly calibrate the flexion gap. The flexion gap instrument of the present invention is especially useful for aligning a cutting block in the A/P direction to make accurate cuts in the condyles.

[0048] The instrument **30** or **80** can be easily used with the knee distraction or ligament tensioning device in its operative position without interfering with the function of the distraction/tensioning device. Moreover, the instruments **30** or **80** provide a clear visual indication of a proper flexion gap to allow accurate positioning of the cutting block or other instrumentation associated with the knee arthroplasty procedure. For instance, the instrument can be used to align a template for positioning fixation pins or for creating an intramedullary bore.

[0049] The flexion gap instrument can be modified to mate with a variety of distraction devices. In the illustrated embodiments, the distraction devices define a slot that receives the base of the flexion gap instrument so that the base can rest on the tibial plateau. The instrument can be modified so that its base rests on the lower plate of the distraction device itself. In this instance, the measurement scale on the flexion gap instrument would need to be modified to account for the thickness of the distraction plate.

## Claims

1. An instrument for establishing the flexion gap of a knee joint in flexion, comprising:

a base portion configured for placement relative to the proximal end of the tibia with the knee joint in flexion;

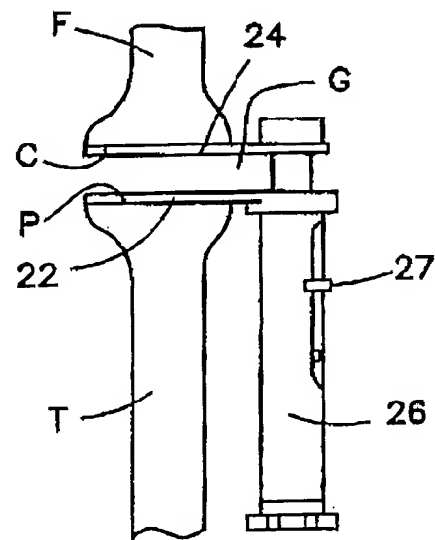
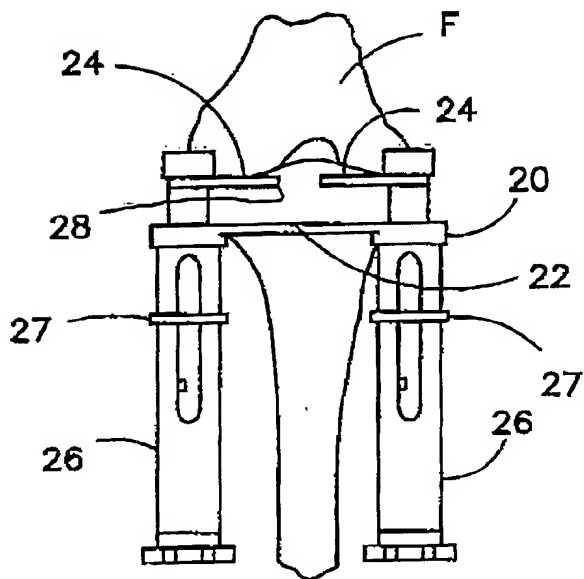
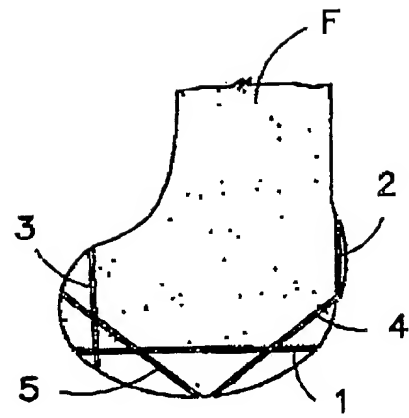
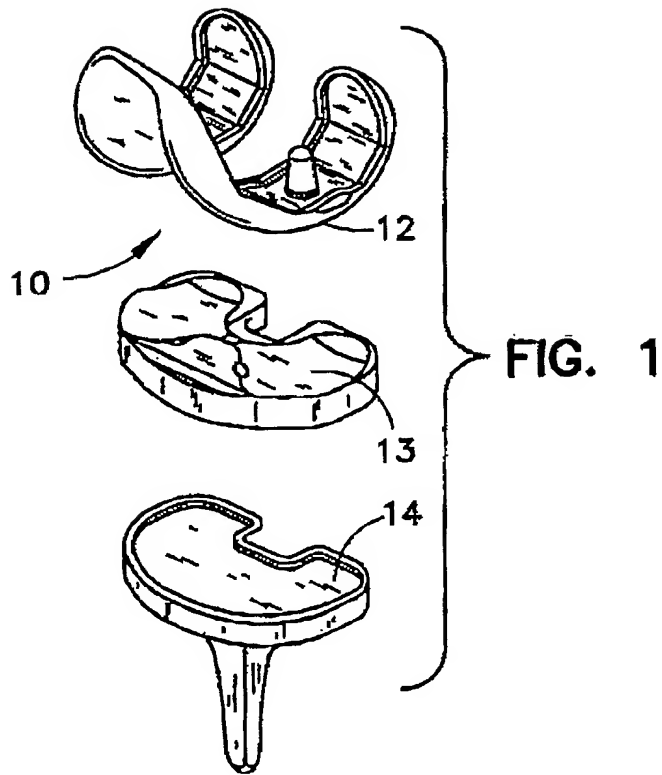
a plate projecting from said base portion and configured to be juxtaposed relative to the distal end of the femur when said base portion is placed relative to the tibia; and

indicia on said plate defining a gap dimension

measured from the proximal end of the tibia.

2. The instrument according to claim 1, wherein at least a portion of said plate bearing said indicia is sized to be slidably received in a channel of a cutting block. 5
3. The instrument according to claim 2, further comprising means for supporting the cutting block on said plate. 10
4. The instrument according to claim 3, wherein said means for supporting includes a leaf spring connected to said plate, said leaf spring arranged to bear against the channel of the cutting block. 15
5. The instrument according to claim 1, wherein said plate projects substantially perpendicularly from said base. 20
6. The instrument according to claim 1, wherein at least a portion of said plate bearing said indicia is oriented at a non-perpendicular angle relative to said base. 25
7. The instrument according to claim 1, wherein said indicia includes a set of scale markings.
8. The instrument according to claim 1, wherein said plate is part of an I-beam upstanding portion projecting from said base. 30
9. The instrument according to claim 1, wherein said plate is part of a T-shaped upstanding portion projecting from said base, said T-shaped upstanding portion sized to be received within a correspondingly shaped channel in a cutting block. 35
10. The instrument according to claim 1, adapted for use with a distraction device having a lower plate for contacting the tibia and an upper plate for contacting the femur defining a slot therethrough, wherein said base portion is sized for positioning within the slot in the upper slot and engagement with the lower plate. 40 45
11. The instrument according to claim 10, in which the slot in the distraction device has a length, wherein said base has a length less than the length of the slot in the distraction device. 50
12. The instrument according to claim 1, wherein said base has opposite ends and said plate projects from said base nearer one of said opposite ends than the other of said opposite ends. 55





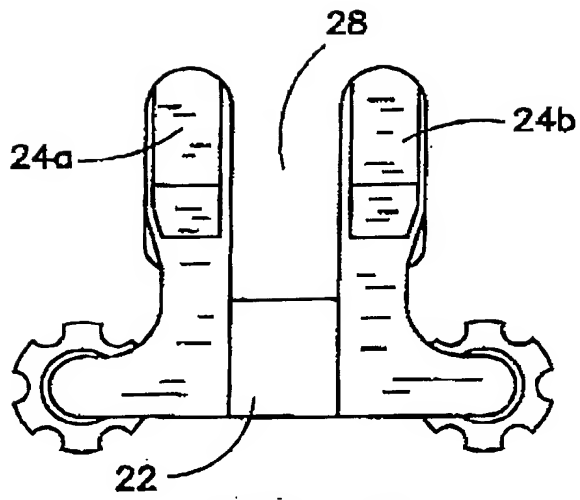


FIG. 5

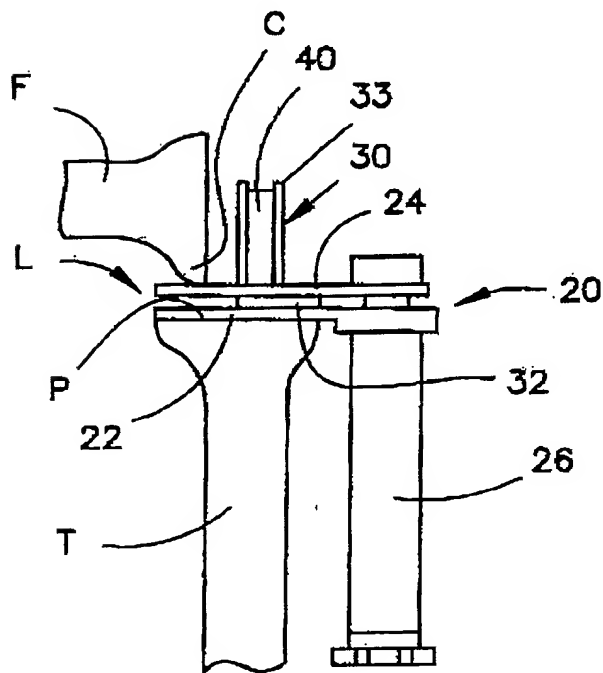


FIG. 7

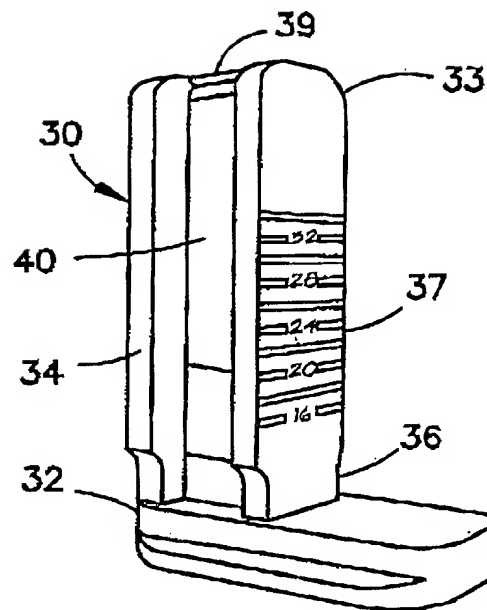


FIG. 6

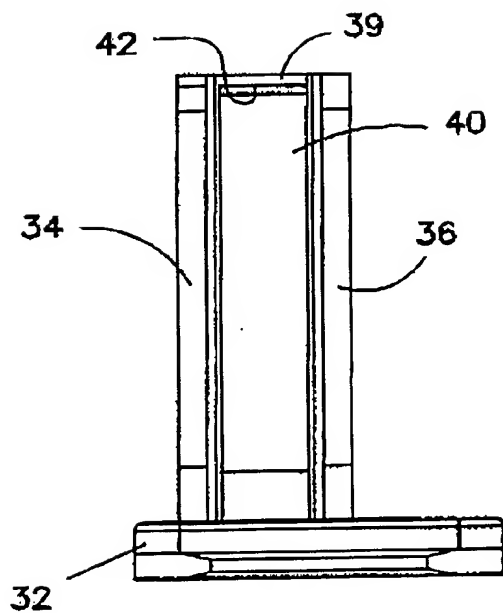


FIG. 8

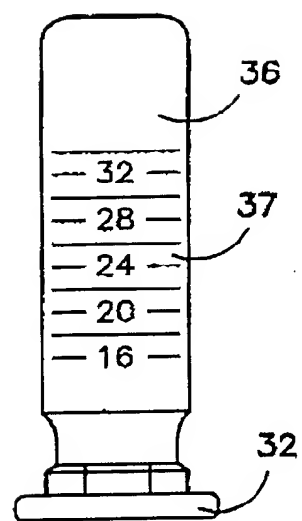


FIG. 9

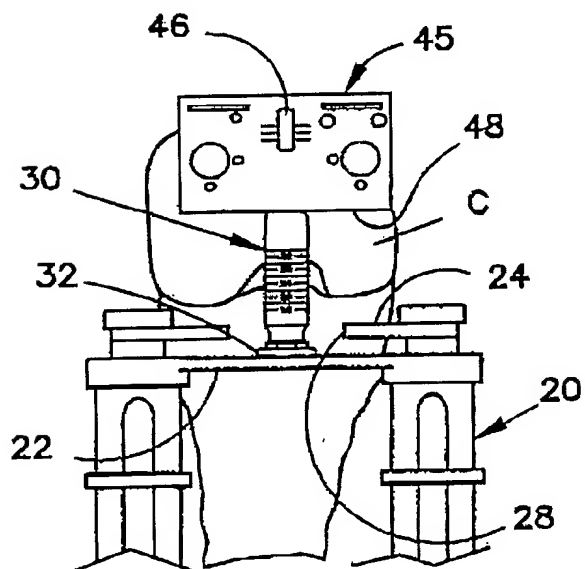


FIG. 10

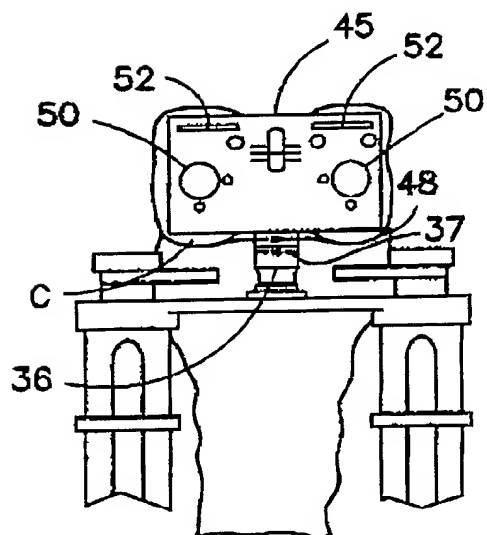


FIG. 11

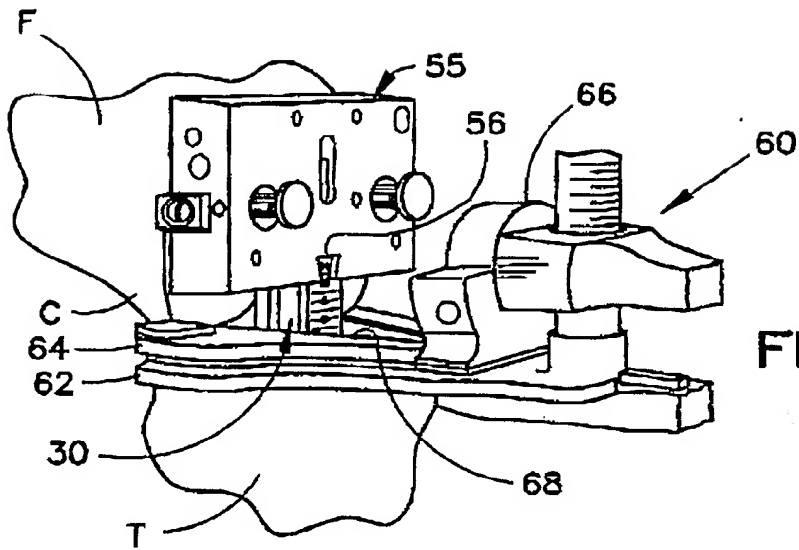


FIG. 12

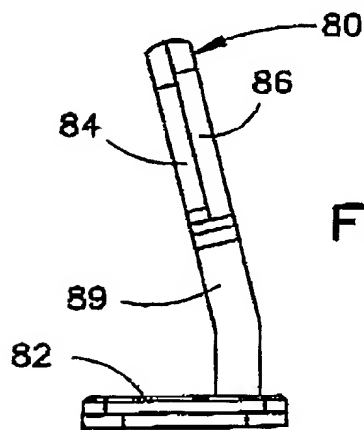


FIG. 14

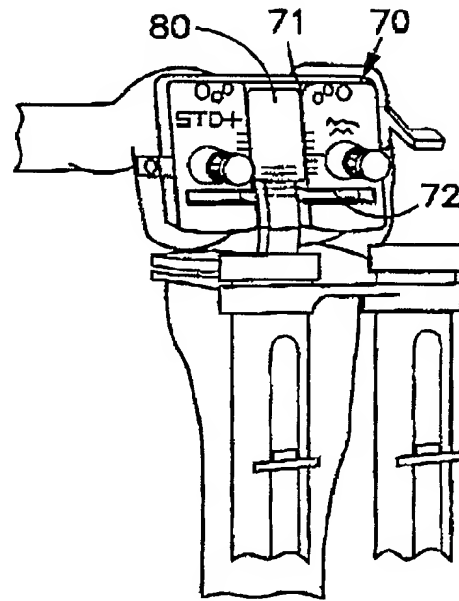


FIG. 13

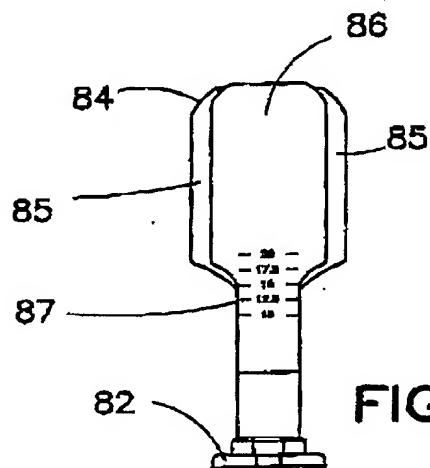


FIG. 15